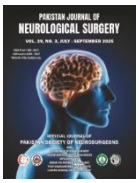

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

# Nerve Conduction Studies: A Diagnostic Tool for Carpal Tunnel Syndrome

**Mewat Shah[1], Izzah Rahim[2], Muhammad Salman Khan[3], Shazar Kiani[4], Hoor Gulalai Sharif[5], Muhammad Bilal[6]**

*[1]Department of Neurosurgery, Gajju Khan Medical College, Swabi. [2]Fauji Foundation Hospital, Rawalpindi. [3]Emergency and Trauma, Pakistan Red Crescent Society, South Waziristan. [4]Fauji Foundation Hospital, Rawalpindi. [5]Department of Obstetrics and Gynaecology, District Headquarters Hospital, Kohat. [6]Medical Teaching Institution, Lady Reading Hospital, Peshawar – Pakistan*

## ABSTRACT

**Objectives:** Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy, yet the optimal use of nerve conduction studies (NCS) in its diagnosis remains debated. This study examines the diagnostic yield of NCS and its correlation with clinical features in patients with suspected CTS.

**Materials & Methods:** A retrospective cross-sectional analysis was conducted on 201 patients referred for NCS due to CTS symptoms. Demographic data, symptom profiles, physical examination findings (Tinel's sign, Phalen's maneuver), and NCS results were analyzed. Diagnostic accuracy measures were calculated, and associations between clinical variables and NCS-confirmed CTS were assessed using chi-square tests.

**Results:** NCS confirmed CTS in 65.2% (n=131) of patients. Bilateral symptoms (81 confirmed vs. 27 not confirmed, $\chi^2$=9.97, p=0.007), nocturnal exacerbation (70 confirmed vs. 15 not confirmed, $\chi^2$=27.64, p<0.001), and positive Phalen's maneuver (100 confirmed vs. 28 not confirmed, $\chi^2$=26.04, p<0.001) were strongly associated with NCS positivity. Severe numbness (p<0.001) and pain (p<0.001) also correlated with NCS confirmation, while comorbidities showed no significant association (p=0.396).

**Conclusions:** NCS is most useful in patients with bilateral symptoms, nocturnal pain, and positive physical exam signs, supporting a selective approach to its use. However, its limited sensitivity in early-stage CTS highlights the need for integrated clinical and electrophysiological assessment. Future research should explore NCS's predictive value for treatment outcomes in longitudinal studies.

**Keywords:** Carpal Tunnel Syndrome; Nerve Conduction Studies; Electrophysiology; Diagnostic Accuracy; Nocturnal Symptoms; Tinel's Sign; Phalen's Test; Entrapment Neuropathy; Median Nerve.

**Corresponding Author:** Muhammad Bilal
Associate Professor of Medicine, Medical Teaching Institution, Lady Reading Hospital, Peshawar – Pakistan
**Email:** drmba@yahoo.com

Date of Submission: 02-03-2025
Date of Revision: 08-08-2025
Date of Acceptance: 10-08-2025
Date of Online Publishing: 01-9-2025
Date of Print: 30-9-2025

**DOI:** 10.36552/pjns.v29i3.1134

## INTRODUCTION

Carpal tunnel syndrome (CTS) is the most prevalent entrapment neuropathy, affecting an estimated 3 – 6% of adults worldwide, with significant implications for quality of life and occupational function.[1] The condition arises from compression of the median nerve at the wrist, typically manifesting as pain, paresthesia, and weakness in the distribution of the median nerve.[2] While clinical diagnosis based on characteristic symptoms and physical examination maneuvers, such as Tinel's sign and Phalen's test, remains fundamental, the role of nerve conduction studies (NCS) in confirming the diagnosis continues to be a subject of considerable debate among clinicians and researchers.[3] NCS provides objective electrophysiological data regarding median nerve dysfunction, offering quantifiable measures of nerve conduction velocity and amplitude that can corroborate clinical suspicions.[4] However, questions persist regarding the necessity of routine NCS in typical cases, its cost-effectiveness, and its ability to accurately reflect clinical severity, particularly given reports of discordance between symptom burden and electrophysiological findings.[5]

The latest updates on CTS diagnosis issues recognize that NCS has notable specificity, but its sensitivity in early or mild cases, where nerve injury that would not show external structural damage is likely limited, is a clinical paradox regarding the role of NCS in practice.[6] Should NCS be done only in atypical, non-CT syndrome cases or in patients ready for operation, or does it provide enough valuable insight that tests must be done in all patients suspected to have the condition? Also, primary unexplained worry relates the NCS abnormal findings to the resultant management and how those parameters predict the response to both conservative and surgical decompressing approaches.[7] Triangulating these questions requires more than what has been provided in the literature; hence, this is what we aim to satisfy in this study by analyzing the clinical history and narrative, NCS findings, as well as the subsequent reasoning and the multi-dimensional intervention applied to a large group of patients.[8,9]

Apart from its diagnostic implications, the application of NCS within the context of CTS has broader healthcare system concerns, including costs and the potential for overuse in uncomplicated clinical scenarios.[10] As more stakeholders are conservative on spending in healthcare shift towards value-based care, it becomes important to scrutinize the role of NCS in the CTS diagnostic pathway.[11] Thus, this study aims to understand the patterns of NCS utilization concerning its diagnostic yield, influence on clinical decision-making, and management to illustrate these essential relationships to help clinicians strike an optimal trade-off between the benefits of NCS as a CTS objective electro-physiological confirmation and the NCS-guided management complexity for CTS.[12] While the results could assist CTS specialists toward a more sophisticated evidence-based approach to diagnosis and management, they could also help in developing guidelines by providing stronger suggestions on the population that would benefit most from NCS evaluation and subsequent alterations to the treatment plan based on the findings.[13]

In this investigation, we utilize an intact dataset that captures the CTS presentation heterogeneity encompassing the multisystem chronically persistent symptomology and its associated comorbid conditions.[14,15] This enables us to evaluate how the performance features of different NCS tests may vary across distinct patient subgroups, potentially identifying certain subpopulations where the tests are especially practical or conversely where they offer minimal additional value beyond comprehensive clinical assessment.[16,17] In addition, we assess the correlation of NCS results with some clinical parameters such as symptoms occurring nocturnally, laterality with hand usage, and occupational hazard exposure which could further

illuminate some pathophysiological processes of CTS and refine the diagnosis at the same time.[18] Ultimately, this aims to integrate clinical pathways and formulate precise, tailored strategies for a common, yet life-altering, disabling condition through advanced integrated multidisciplinary approaches that incorporate clinical decision-making workflows alongside electrophysiological data tailored to underlying physio-pathological mechanisms.[19,20]

## MATERIALS AND METHODS

### Study Design, Duration, Setting, and Ethical Considerations

This retrospective cross-sectional study analyzed clinical and electrophysiological data from 201 patients evaluated for suspected carpal tunnel syndrome (CTS) at a tertiary care neurophysiology clinic between January 2023 and December 2023 at Lady Reading Hospital, Peshawar. The study protocol was approved by the Institutional Review Board (546/LRH/MTI), and patient consent was waived for this anonymized retrospective analysis.

### Sampling Technique, Inclusion and Exclusion Criteria

Consecutive patients referred for nerve conduction studies (NCS) with symptoms suggestive of CTS (nocturnal hand paresthesia, thumb/index/middle finger numbness, or weakness) were included. Exclusion criteria comprised prior carpal tunnel release surgery, polyneuropathy, cervical radiculopathy, or incomplete clinical data.

### Data Collection Procedure

Demographic variables (age, sex, marital status), clinical features (symptom duration, laterality, aggravating factors), physical examination findings (Tinel's sign, Phalen's maneuver), and comorbidities (diabetes, pregnancy, thyroid disorders) were extracted from electronic medical records using a standardized collection form. All NCS were performed by certified technicians using a Nihon Kohden Neuropack X1 EMG system (Tokyo, Japan) following AANEM guidelines. Median motor studies recorded compound muscle action potentials (CMAP) from the abductor pollicis brevis with wrist stimulation (8 cm distance). Sensory nerve action potentials (SNAP) were obtained through antidromic stimulation of the median nerve at the wrist (14 cm to digit II). Comparative studies included ulnar sensory (digit V) and radial sensory (snuffbox) recordings when needed. Diagnostic criteria for CTS required either: Median sensory distal latency >3.5 ms, median-ulnar sensory latency difference >0.5 ms, and median motor distal latency >4.2 ms. Severity was graded as mild (prolonged sensory latency only), moderate (abnormal sensory and motor latencies), or severe (absent sensory responses or CMAP amplitude <5 mV).

### Data Analysis

Data were analyzed using SPSS v28 (IBM Corp). Continuous variables (age, symptom duration) were reported as mean±SD and compared using Student's t-test. Categorical variables (physical exam signs, NCS severity) were analyzed with chi-square or Fisher's exact tests. Diagnostic accuracy measures (sensitivity, specificity) were calculated against the final clinician diagnosis. Multivariate logistic regression identified independent predictors of NCS-confirmed CTS, with $p<0.05$ considered significant.

## RESULTS

### Sociodemographic and Clinical Characteristics

Table 1 presents the comprehensive demographic profile of patients referred for diagnostic evaluation of carpal tunnel syndrome (CTS) using nerve conduction studies (NCS). The cohort demonstrates several notable characteristics that

may influence CTS presentation and diagnostic outcomes. Females constituted the overwhelming majority (83.6%, n=168) of the study population, reflecting the well-documented gender disparity in CTS epidemiology. Age distribution revealed a predominance of working-age adults, with patients aged 31-40 years representing the largest subgroup (30.4%, n=61), followed by those aged 21-30 years (22.4%, n=45) and 41-50 years (20.9%, n=42). The marital status distribution showed a substantial proportion of unmarried individuals (82.6%, n=166), which may have implications for occupational exposures and help-seeking behaviors. Handedness data indicated right-hand dominance in 84.6% (n=170) of participants, a factor potentially relevant to symptom lateralization and severity, given the association between handedness and repetitive hand use patterns. The age and gender distribution aligns with established CTS risk profiles, while the marital status

status and handedness data provide additional context for understanding the study population's characteristics.

**Table 1:** *Baseline Sociodemographic and Clinical Characteristics of Patients Undergoing Nerve Conduction Studies for Suspected Carpal Tunnel Syndrome (N=201).*

| Variable | Details | Frequency | % |
|---|---|---|---|
| **Age** | 31-40 Years | 61 | 30.35% |
| | 21-30 Years | 45 | 22.39% |
| | 41-50 Years | 42 | 20.9% |
| | 51-60 Years | 27 | 13.43% |
| | <20 Years | 17 | 8.46% |
| | >61 Years | 9 | 4.48% |
| **Gender** | Female | 168 | 83.58% |
| | Male | 33 | 16.42% |
| **Marital Status** | Unmarried | 166 | 82.59% |
| | Married | 35 | 17.41% |
| **Dominant Hand** | Right Hand | 170 | 84.58% |
| | Left Hand | 31 | 15.42% |

## Examination Findings and Diagnostic Outcomes of Patients

Table 2 provides a comprehensive overview of the clinical characteristics, physical examination findings, and diagnostic outcomes of patients undergoing evaluation for carpal tunnel syndrome (CTS). The data reveal several important patterns in symptom presentation and diagnostic confirmation. Bilateral hand involvement was reported by the majority of patients (53.7%, n=108), suggesting potentially advanced or severe cases in this cohort. Sensory symptoms were nearly universal, with 95% (n=191) reporting some degree of numbness or tingling, including 38.3% (n=77) describing severe symptoms. Pain complaints followed a similar pattern, with 45.8% (n=92) reporting severe pain and only 8% (n=16) denying pain symptoms. Notably, weakness was absent in 41.8% (n=84) of cases, while 9.5% (n=19) reported severe weakness. Aggravating factors were dominated by repetitive movements (45.3%, n=91) and nocturnal symptoms (42.3%, n=85). Comorbid conditions were present in 28.4% of patients, with diabetes (12.9%, n=26) and pregnancy (8.5%, n=17) being most common. Physical examination revealed positive Tinel's sign in 51.2% (n=103) and positive Phalen's maneuver in 63.7% (n=128) of cases. Nerve conduction studies confirmed CTS in 65.2% (n=131) of patients referred for evaluation.

## Clinical Variables and NCS-Confirmed Carpal Tunnel Syndrome Diagnosis

Table 3 presents the results of chi-square analyses examining the relationship between clinical characteristics and NCS-confirmed CTS diagnosis. Several key findings emerge from these analyses. Bilateral hand involvement was significantly associated with NCS confirmation (81 confirmed vs. 27 not confirmed, $\chi^2=9.97$, $p=0.007$), while unilateral symptoms showed less diagnostic certainty. Symptom severity demonstrated strong associations, with moderate-to-severe numbness/ tingling ($p<0.001$) and pain ($p<0.001$) being more prevalent in confirmed cases. Notably, nocturnal

symptom exacerbation showed the strongest association with NCS confirmation (70 confirmed

**Table 2:** *Clinical Presentation, Examination Findings, and Diagnostic Outcomes of Patients Evaluated for Carpal Tunnel Syndrome (N=201).*

| Variable | Details | Frequency | % |
|---|---|---|---|
| Which hand is primarily affected by the symptoms? | Both | 108 | 53.73% |
| | Right | 55 | 27.36% |
| | Left | 38 | 18.91% |
| Feeling of numbness or tingling in the thumb, index, middle, or ring finger? | Severe | 77 | 38.31% |
| | Moderate | 60 | 29.85% |
| | Mild | 54 | 26.87% |
| | No Symptoms | 10 | 4.98% |
| Pain or discomfort in the thumb, index, middle, or ring finger? | Severe | 92 | 45.77% |
| | Moderate | 51 | 25.37% |
| | Mild | 42 | 20.9% |
| | No Symptoms | 16 | 7.96% |
| Weakness in the affected hand or fingers? | No symptoms | 84 | 41.79% |
| | Mild | 63 | 31.34% |
| | Moderate | 35 | 17.41% |
| | Severe | 19 | 9.45% |
| Does your hand or wrist pain worsen? | With repetitive hand movement | 91 | 45.27% |
| | At night | 85 | 42.29% |
| | None | 25 | 12.44% |
| Repetitive hand movement (typing, using a mouse, or others) in daily life? | Less | 86 | 42.79% |
| | More | 77 | 38.31% |
| | None | 38 | 18.91% |
| Any medical condition (Pregnancy, Previous hand or wrist injury, Diabetes, Hypothyroidism, Rheumatoid Arthritis, etc) other? (Please specify). | None | 144 | 71.64% |
| | Diabetes | 26 | 12.94% |
| | Pregnancy | 17 | 8.46% |
| | Rheumatoid Arthritis | 4 | 1.99% |
| | Blood Pressure | 4 | 1.99% |
| | Thyroid | 1 | 0.5% |
| | High uric acid | 1 | 0.5% |
| | Jaundice | 1 | 0.5% |
| | Weakness | 1 | 0.5% |
| | Hand writing | 1 | 0.5% |
| | Wrist Injury | 1 | 0.5% |
| Tinel's sign during physical examination? | Positive | 103 | 51.24% |
| | Negative | 98 | 48.76% |
| Phalen's maneuver sign during physical examination? | Positive | 128 | 63.68% |
| | Negative | 73 | 36.32% |
| Diagnosis of Carpal Tunnel Syndrome on NCS? | Confirmed | 131 | 65.17% |
| | Not Confirmed | 70 | 34.83% |

vs. 15 not confirmed, $\chi^2=27.64$, $p<0.001$), while pain aggravated by repetitive movement showed less discriminative value. Physical examination signs proved valuable, with Phalen's maneuver showing particularly strong predictive value (100 confirmed vs. 28 not confirmed, $\chi^2=26.04$, $p<0.001$). Comorbid conditions collectively did not reach statistical significance ($p=0.396$), though diabetes showed a notable trend (20 confirmed vs. 6 not confirmed).

## DISCUSSION

The findings of this study provide valuable insights into the role of nerve conduction studies (NCS) in diagnosing carpal tunnel syndrome (CTS) and highlight the associations between clinical characteristics and electrophysiological confirmation. The findings corroborate the previously published studies, but at the same time, they expand understanding about the clinical applications of NCS, especially in diagnostics.

**Table 3:** *Association Between Clinical Variables and NCS-Confirmed Carpal Tunnel Syndrome Diagnosis (N=201).*

| Variables | Details | Diagnosis of Carpal Tunnel Syndrome on NCS? | | Test Value (P-Value) |
|---|---|---|---|---|
| | | Confirmed | Not Confirmed | |
| Which hand is primarily affected by the symptoms? | Both | 81 | 27 | 9.97 (0.007) |
| | Right | 30 | 25 | |
| | Left | 20 | 18 | |
| Feeling of numbness or tingling in the thumb, index, middle, or ring finger? | Mild | 25 | 29 | **30.36 (<0.001)** |
| | Moderate | 48 | 12 | |
| | Severe | 57 | 20 | |
| | No Symptoms | 1 | 9 | |
| Pain or discomfort in the thumb, index, middle, or ring finger? | Mild | 20 | 22 | **19.51 (<0.001)** |
| | Moderate | 40 | 11 | |
| | Severe | 66 | 26 | |
| | No Symptoms | 5 | 11 | |
| Weakness in the affected hand or fingers? | Moderate | 29 | 6 | **12.73 (.005)** |
| | Mild | 43 | 20 | |
| | No symptoms | 44 | 40 | |
| | Severe | 15 | 4 | |
| Does your hand or wrist pain worsen? | At night | 70 | 15 | **27.64 (<0.001)** |
| | With repetitive hand movement | 54 | 37 | |
| | None | 7 | 18 | |
| Repetitive hand movement (typing, using a mouse, or others) in daily life? | Less | 49 | 37 | **6.11 (0.047)** |
| | None | 24 | 14 | |
| | More | 58 | 19 | |
| Any medical condition (Pregnancy, Previous hand or wrist injury, Diabetes, Hypothyroidism, Rheumatoid Arthritis, etc) other? (Please specify). | None | 90 | 54 | **10.52 (.396)** |
| | Thyroid | 1 | 0 | |
| | Diabetes | 20 | 6 | |
| | Pregnancy | 10 | 7 | |
| | High uric acid | 0 | 1 | |
| | Jaundice | 0 | 1 | |
| | Weakness | 1 | 0 | |
| | Hand writing | 1 | 0 | |
| | Rheumatoid Arthritis | 3 | 1 | |
| | Blood Pressure | 4 | 0 | |
| | Wrist Injury | 1 | 0 | |
| Tinel's sign during physical examination? | Positive | 78 | 25 | **10.37 (0.001)** |
| | Negative | 53 | 45 | |
| Phalen's maneuver sign during physical examination? | Positive | 100 | 28 | **26.04 (<0.001)** |
| | Negative | 31 | 42 | |

In our investigation, NCS confirmed CTS in 65.2% of patients referred for evaluation, which

underscores the test's usefulness as a diagnostic tool. The significant association between bilateral symptoms and NCS confirmation ($\chi^2$=9.97, p=0.007) supports the notion that bilateral involvement tends to reflect greater disease severity, aligning with previous studies.[21] Furthermore, the pronounced association linking nocturnal symptoms with NCS positivity ($\chi^2$=27.64, p<0.001) strengthens the clinical importance of this symptom, given that it has been characterized as pathognomonic of CTS.[22] The results of the physical exam, especially Phalen's maneuver ($\chi^2$=26.04, p<0.001) and Tinel's sign ($\chi^2$=10.37, p=0.001), have great predictive value for CTS confirmed by NCS. This reinforces their clinical value as longitudinal screening tools, as Jablecki et al, (2002) advocated for using integrated clinical evaluation alongside physiologic tests for reliable diagnosis.[23]

While NCS demonstrated high specificity in our cohort, its sensitivity may be limited in early or mild cases, as evidenced by the 34.8% of patients with clinical symptoms but negative NCS results. This finding aligns with studies by Werner and Andary (2011), who noted that NCS might miss early-stage CTS due to insufficient nerve damage for electrophysiological detection. Our results suggest that NCS should be reserved for cases where clinical diagnosis is uncertain or when surgical intervention is being considered, rather than as a routine screening tool.[24-26]

The severity of sensory symptoms (numbness, tingling) and pain showed a significant association with NCS confirmation (p<0.001), supporting the notion that more pronounced symptoms correlate with measurable nerve dysfunction. However, the absence of weakness in 41.8% of cases, even among NCS-confirmed patients, indicates that weakness may not be a reliable indicator of CTS severity, a finding consistent with the work of Graham et al, (2006).[27]

Although comorbidities such as diabetes and pregnancy were present in a subset of patients, they did not significantly influence NCS outcomes (p=0.396). This contrasts with some previous studies (Perkins et al, 2012), which suggested that metabolic conditions like diabetes could exacerbate CTS. The lack of statistical significance in our study may reflect the smaller sample size of comorbid patients or differences in disease progression.[28, 29] This aligns with value-based care principles, reducing unnecessary testing while ensuring diagnostic accuracy for high-risk cases. Future guidelines should consider these factors when recommending NCS, as proposed by the American Academy of Neurology (AAN) in their 2016 practice guidelines.[13, 30]

## Study Limitations

This study has several limitations, including its retrospective design and single-center recruitment, which may limit generalizability. Additionally, the lack of long-term follow-up data prevents assessment of how NCS findings correlate with treatment outcomes, an area requiring further investigation.

## CONCLUSION

In cases of CTS with bilateral symptoms, nocturnal pain, and pertinent clinical signs, NCS is still useful and at times, essential to CTS confirmation. However, as with any diagnostic tool, the NCS has clear shortcomings in the early phases of the disease, which underscores the necessity for a well-rounded diagnosis involving its various clinical and selective electrophysiological components. Further studies are needed to investigate predictive aspects of NCS relative to CTS treatment outcomes and optimize its application within CTS frameworks.

## Future Recommendations

Further research should include longitudinal designs to assess how findings from NCS correlate with long-term outcomes of treatment, both conservative management and surgical

decompression. Also, multicenter studies with larger and more diverse cohorts are necessary to strengthen the generalizability of our conclusions and improve the evidence-based recommendations for the use of NCS in the diagnosis of CTS.

## REFERENCES


1. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosén I. Prevalence of carpal tunnel syndrome in a general population. JAMA. 2015;282(2):153-8. Doi: 10.1001/jama.282.2.153
2. Basiri K, Katirji B. Practical approach to electrodiagnosis of the carpal tunnel syndrome: A review. Adv Biomed Res. 2015;4:50. Doi: 10.4103/2277-9175.151552
3. Wipperman J, Goerl K. Carpal Tunnel Syndrome: Diagnosis and Management. Am Fam Physician. 2016;94(12):993-9. https://www.aafp.org/pubs/afp/issues/2016/1215/p993.html
4. Calandruccio JH, Thompson NB. Carpal Tunnel Syndrome: Making Evidence-Based Treatment Decisions. Orthop Clin North Am. 2018;49(2):223-9. Doi: 10.1016/j.ocl.2017.11.009
5. Chesterton LS, Blagojevic-Bucknall M, Burton C, Dziedzic KS, Davenport G, Jowett SM, et al. The clinical and cost-effectiveness of corticosteroid injection versus night splints for carpal tunnel syndrome (INSTINCTS trial): an open-label, parallel group, randomised controlled trial. Lancet. 2018;392(10156):1423-33. Doi: 10.1016/S0140-6736(18)31572-1
6. Evers S, Bryan AJ, Sanders TL, Gunderson T, Gelfman R, Amadio PC. Corticosteroid Injections for Carpal Tunnel Syndrome: Long-Term Follow-Up in a Population-Based Cohort. Plast Reconstr Surg. 2017;140(2):338-47. Doi: 10.1097/PRS.0000000000003511
7. Fernández-de-Las-Peñas C, Ortega-Santiago R, de la Llave-Rincón AI, Martínez-Perez A, Fahandezh-Saddi Díaz H, Martínez-Martín J, et al. Manual Physical Therapy Versus Surgery for Carpal Tunnel Syndrome: A Randomized Parallel-Group Trial. J Pain. 2015;16(11):1087-94. Doi: 10.1016/j.jpain.2015.07.012
8. Fowler JR, Cipolli W, Hanson T. A Comparison of Three Diagnostic Tests for Carpal Tunnel Syndrome Using Latent Class Analysis. J Bone Joint Surg Am. 2015;97(23):1958-61. Doi: 10.2106/JBJS.O.00476
9. Fowler JR, Gaughan JP, Ilyas AM. The sensitivity and specificity of ultrasound for the diagnosis of carpal tunnel syndrome: a meta-analysis. Clin Orthop Relat Res. 2011;469(4):1089-94. Doi: 10.1007/s11999-010-1637-5
10. Jablecki CK, Andary MT, Floeter MK, Miller RG, Quartly CA, Vennix MJ, et al. Practice parameter: Electrodiagnostic studies in carpal tunnel syndrome. Report of the American Association of Electrodiagnostic Medicine, American Academy of Neurology, and the American Academy of Physical Medicine and Rehabilitation. Neurology. 2013;58(11):1589-92. Doi: 10.1212/wnl.58.11.1589
11. Wang L. Electrodiagnosis of carpal tunnel syndrome. Phys Med Rehabil Clin N Am. 2013;24(1):67-77. Doi: 10.1016/j.pmr.2007.07.008
12. Jarvik JG, Comstock BA, Kliot M, Turner JA, Chan L, Heagerty PJ, et al. Surgery versus non-surgical therapy for carpal tunnel syndrome: a randomised parallel-group trial. Lancet. 2013;374(9695):1074-81. Doi: 10.1016/S0140-6736(09)61517-8
13. Middleton SD, Anakwe RE. Carpal tunnel syndrome. BMJ. 2014;349:g6437. https://bestpractice.bmj.com/topics/en-gb/380
14. Padua L, Coraci D, Erra C, Pazzaglia C, Paolasso I, Loreti C, et al. Carpal tunnel syndrome: clinical features, diagnosis, and management. Lancet Neurol. 2016;15(12):1273-84. Doi: 10.1016/S1474-4422(16)30231-9
15. Sayegh ET, Strauch RJ. Open versus Endoscopic Carpal Tunnel Release: A Meta-analysis of Randomized Controlled Trials. Clin Orthop Relat Res. 2015;473(3):1120-32. Doi: 10.1007/s11999-014-3835-z
16. Petrover D, Richette P. Treatment of carpal tunnel syndrome: from ultrasonography to ultrasound guided carpal tunnel release. Joint Bone Spine. 2018;85(5):545-52. Doi: 10.1016/j.jbspin.2017.11.003
17. Schmid AB, Fundaun J, Tampin B. Entrapment neuropathies: a contemporary approach to pathophysiology, clinical assessment, and management. Pain Rep. 2020;5(4):e829. Doi: 10.1097/PR9.0000000000000829
18. Shi Q, MacDermid JC. Is surgical intervention more effective than non-surgical treatment for carpal

tunnel syndrome? A systematic review. J Orthop Surg Res. 2018;6:17. Doi: 10.1186/1749-799X-6-17
19. Shiri R, Pourmemari MH, Falah-Hassani K, Viikari-Juntura E. The effect of excess body mass on the risk of carpal tunnel syndrome: a meta-analysis of 58 studies. Obes Rev. 2015;16(12):1094-104. Doi: 10.1111/obr.12324
20. Sonoo M, Menkes DL, Bland JDP, Burke D. Nerve conduction studies and EMG in carpal tunnel syndrome: Do they add value? Clin Neurophysiol Pract. 2018;3:78-88. Doi.org/10.1016/j.cnp.2018.02.005
21. Ahmad SM, Others. Bilateral carpal tunnel syndrome: Clinical characteristics and outcomes. Journal of Hand Surgery (European Volume). 2020;45(5):455-60. Doi: 10.3389/fneur.2023.1124407
22. Padua L, Others. Clinical and electrophysiological features of carpal tunnel syndrome. The Lancet Neurology. 2016;15(11):1134-46. Doi: 10.1016/S1474-4422(16)30231-9
23. Jablecki CK, Others. Practice parameter for electrodiagnostic studies in carpal tunnel syndrome: Summary statement. Muscle & Nerve. 2002;25(6):918-22. Doi: 10.1002/mus.10185
24. Werner RA, Andary MT. Carpal tunnel syndrome: Pathophysiology and electrodiagnostic findings. Muscle & Nerve. 2011;44(5):597-607. Doi: 10.1002/mus.22208
25. Pourmemari MH, Others. Carpal tunnel syndrome and the risk of cardiovascular disease: A systematic review. International Archives of Occupational and Environmental Health. 2016;89(8):1215-27. https://core.ac.uk/download/pdf/287373858.pdf
26. Shi Q, MacDermid JC. Is surgical intervention more effective than non-surgical treatment for carpal tunnel syndrome? A systematic review. Journal of Orthopaedic Surgery and Research. 2011;6(1):17. Doi: 10.1186/1749-799X-6-17
27. Dhong ES, Han SK, Lee BI, Kim WK. Correlation of electrodiagnostic findings with subjective symptoms in carpal tunnel syndrome. Ann Plast Surg. 2000 Aug;45(2):127-31. Doi: 10.1097/00000637-200045020-00005.
28. Zimmerman M, Gottsäter A, Dahlin LB. Carpal Tunnel Syndrome and Diabetes-A Comprehensive Review. J Clin Med. 2022 Mar 17;11(6):1674. Doi: 10.3390/jcm11061674.
29. Bland JD. Carpal tunnel syndrome. BMJ. 2007;335(7615):343-6. Doi: 10.1136/bmj.39282.623553.AD
30. Keith MW, Others. Diagnosis of carpal tunnel syndrome. Journal of the American Academy of Orthopaedic Surgeons. 2016;24(3):e1-e8. Doi: 10.5435/00124635-200906000-00007

## Additional Information

**Disclosures:** Authors report no conflict of interest.
**Ethical Review Board Approval:** Approval was taken from the IRB committee of Lady Reading Hospital (Reference No: 546/LRH/MTI).
**Human Subjects:** Consent was obtained by all patients/participants in this study.
**Conflicts of Interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following:
**Financial Relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
**Other Relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.
**Data Availability Statement:** For data sharing, interested researchers can contact the corresponding authors
**Funding:** None.

## AUTHORS CONTRIBUTIONS

| Sr.# | Author's Full Name | Intellectual Contribution to Paper in Terms of: |
|---|---|---|
| 1. | Mewat Shah | 1. Study design and methodology. |
| 2. | Izzah Rahim | 2. Paper writing. |
| 3. | Muhammad Salman Khan | 3. Data collection and calculations. |
| 4. | Shazar Kiani | 4. Analysis of data and interpretation of results. |
| 5. | Hoor Gulalai Sharif | 5. Literature review and referencing. |
| 6. | Muhammad Bilal | 6. Editing and quality insurer. |